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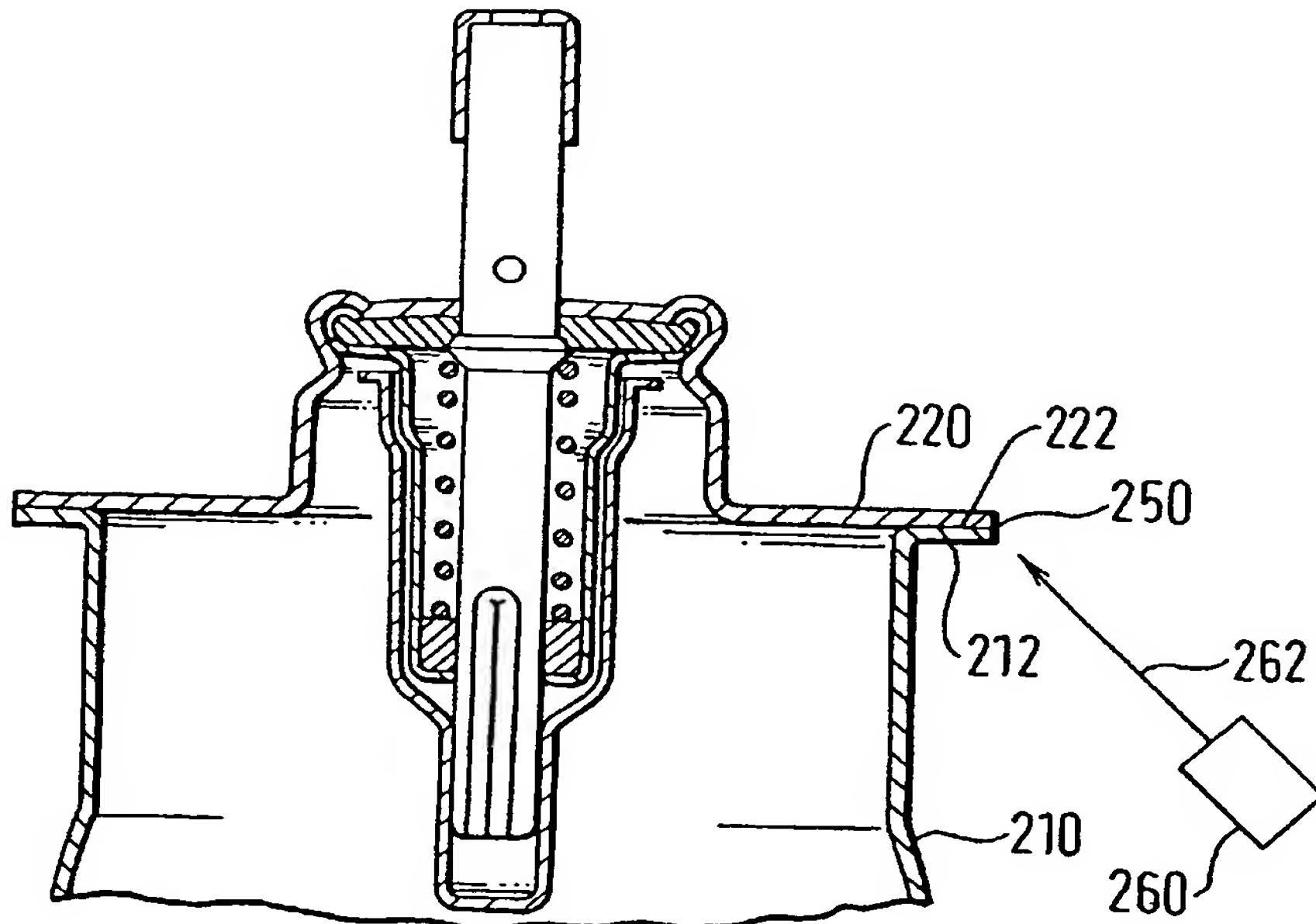
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(54) Title: DISPENSER



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(57) Abstract: There is provided an aerosol dispenser comprising a body and a closure sealed to the body; the closure comprising an annular metal ferrule extending circumferentially around the axis of the closure and provided with a valve arrangement for dispensing material from the interior of the dispenser, characterised in that the closure welds directly to the body by an overlapping metal-to-metal laser weld extending around the body to produce a double weld in the region of overlap and provide a hermetic seal between the mating surfaces of the body and the ferrule.

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## DISPENSER

### Technical Field

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This invention relates to an aerosol dispenser, in particular to a medicament dispenser for dispensing metered doses of medicament. In another aspect, the invention also relates to a method for assembling aerosol dispensers using laser welding to hermetically seal the dispenser.

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### Background to Invention

Medicinal aerosol dispensers typically comprise a metal container enclosing a pressurised medicament formulation and a valve arrangement for dispensing metered drug doses. The valve arrangement is generally attached to the dispenser by crimping a ferrule against the body of the container. An elastomeric gasket or O-ring, compressed between the body and the ferrule, is frequently used to seal the container.

15      Although the materials used for gaskets in aerosol dispensers are carefully chosen when medical applications are involved, to be as inert as possible, it is nevertheless recognised that it is desirable to reduce the amount of gasket material which can come into contact with the material to be dispensed. Indeed it is particularly desirable to totally eliminate the need for such gaskets in medicinal aerosol dispensers. Such elimination also potentially offers the prospect of reduced manufacturing costs compared to those for conventional dispensers by virtue of the fact that it uses one less component.

20      It is also desirable to ensure that the aerosol dispenser is as leak-proof as possible. In particular, it is desirable to prevent the leakage of moisture into

the container where it can interfere with the integrity of any aerosol formulation contained therein. Although gaskets perform well in this respect, they do offer a potential leakage path extending circumferentially around the container. For that reason also, it would be desirable to eliminate the need 5 for a gasket and provide a hermetic seal between the body and closure which offered no such potential leakage path.

Welding techniques offer a potential solution to the above mentioned problems. Ultrasound and laser welding techniques have been reported in 10 the art as means for sealing aerosol dispensers.

Thus French Patent Application No. 2543923 describes an aerosol dispenser comprising a dome shaped upper closure laser welded to a body portion. However, although not specified in the application, this arrangement 15 does not produce a hermetic seal and a gasket is required to improve the sealing properties of the dispenser.

International Publication No. WO 00/35772 employs laser welding to address the above mentioned problems. Although this technique eliminates the need 20 for a sealing gasket in an aerosol dispenser, the strength of the laser weld produced is somewhat variable. Inert gases, such as Argon, used to purge the weld area during the welding process, can expand rapidly on heating and rupture discrete areas of the weld. Furthermore, a single circumferential weld can sometimes lack robustness and moisture resistance, particularly at the 25 point of weld juncture.

According to one aspect of the present invention there is provided an aerosol dispenser comprising a body and a closure sealed to the body; the closure comprises an annular metal ferrule extending circumferentially around the 30 axis of the closure and provided with a valve arrangement for dispensing material from the interior of the dispenser, characterised in that the closure

welds directly to the body by an overlapping metal-to-metal laser weld extending around the body to produce a double weld in the region of overlap and provide a hermetic seal between the mating surfaces of the body and the ferrule.

5

In one aspect, the overlapping weld is a continuous weld which extends from 365 to 720 degrees around the axis of the body and the closure, giving a double weld which overlaps by 5 to 360 degrees. Preferably the weld extends from 380 to 540 degrees around the axis and gives a double weld which overlaps by 20 to 180 degrees.

10

In another aspect, the mating surfaces of the ferrule or the body comprise one or more dimples or indents to enable release of purging gases during the welding process. Examples of gases used to purge the weld area during the welding process are the inert gases such as Helium or Argon.

15

In a further aspect, the overlapping weld is between the ferrule and an annular flange forming part of the body, the flange being axially directed and cylindrical.

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Preferably, the overlapping weld is between the ferrule and an annular flange forming part of the body, the ferrule and flange being outwardly directed and flat.

25

In one aspect the dispenser is charged with an aerosol suspension. Preferably the aerosol suspension comprises a medicament and a propellant. More preferably, the medicament is selected from the group consisting of albuterol, salmeterol, fluticasone propionate and beclomethasone dipropionate and salts or solvates thereof and any mixtures thereof. More preferably, the propellant is selected from the group consisting of 1,1,1,2-tetrafluoroethane and 1,1,1,2,3,3-heptafluoropropane.

According to another aspect of the present invention, there is provided a method of assembling an aerosol dispenser comprising a metal body and a closure, the closure comprising an annular ferrule extending circumferentially around the axis of the closure and provided with a valve arrangement for dispensing material from the interior of the dispenser, characterised by applying laser energy to the mating surfaces of the ferrule and the body to produce an overlapping metal-to-metal laser weld extending around the body to form a double weld in the region of overlap and provide a hermetic seal between the body and the ferrule.

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In one aspect, the ferrule is positioned at the open end of and co-axially with the body such that the mating surfaces are in contact with each other.

15

In another aspect, the weld is a continuous weld extending from 365 to 720 degrees about the axis of the body and the closure, giving a double weld which overlaps by 5 to 360 degrees. Preferably the weld extends from 380 to 540 degrees about the axis to give a double weld which overlaps by 20 to 180 degrees.

20

In a further aspect, the mating surfaces comprise one or more dimples or indents to enable release of purging gases which expand on heating during the welding process. For example, three dimples or indents, spaced at 120 degree intervals around the circumference of the ferrule or the body, may be employed to facilitate release of the inert purging gases (such as Helium or 25 Argon).

30

In yet another aspect, the laser energy is applicable at an angle of from 10 to 80 degrees to the axis of orientation of the mating surfaces of the ferrule and body. Preferably the angle is from 20 to 40 degrees. The angle is selected to equilibrate and slow heating of the ferrule relative to the container body

(which can dissipate heat more effectively) otherwise the ferrule melts too rapidly for an effective weld.

In another aspect, the closure is positioned at the open end of and co-axially 5 with the body, the body comprising a complementary annular flange extending circumferentially about its axis such that the ferrule and the flange are parallel and in contact with each other. Preferably, the ferrule and the flange are outwardly directed and flat. More preferably, the ferrule and the 10 flange are bent to lie in a substantially axial direction after the ferrule and the flange have been welded together. More preferably, the ferrule and flange are axially directed and cylindrical.

In a further aspect the ferrule and the flange are first welded together then 15 rolled and crimped together. Preferably, the ferrule and flange are first rolled and crimped together then laser welded to each other.

In one aspect, the laser welding is conducted by means of a laser source having a maximum average power of from 10W to 200W, and a maximum peak power of from 1kW to 10kW. The laser source can be any source 20 suitable for laser welding, including carbon dioxide, diode, fibre and copper vapour laser sources. The laser beam can also be generated by a Q-switched Neodymium Yttrium Aluminium Garnate laser source. An AM 183 (1.8 kW) Yttrium Aluminium Garnate laser source is particularly useful in this respect.

25 Preferably the laser source has a pulse width of from 0.5 to 20 microseconds and a maximum pulse energy of from 10 to 100 Joules. More preferably, the laser source utilises a square wave modulated beam.

30 In another aspect, the width of the weld produced is in the range of 0.4 to 0.8 millimetres. Preferably, the width of the weld produced is 0.6 millimetres.

### **Brief Description of the Drawings**

Further characteristics of the invention will become apparent from the following description and accompanying drawings, wherein:

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Figure 1 is a section perspective of a prior art aerosol dispenser;

Figure 2 is a sectional perspective of an embodiment of the invention;

10 Figure 3 is a sectional perspective of the embodiment of Figure 2 illustrating welding of the ferrule to an annular, planar flange.

Figure 4 is a sectional perspective of the embodiment of Figure 2 illustrating welding of the ferrule to an annular, axial flange.

15

Figure 5 shows a detail of a modification of the embodiment of Figure 3;

Figure 6 shows a further embodiment of the invention; and

20 Figures 7a to 7c show successive steps in assembling the embodiment of Figure 6.

Figure 8 shows a schematic representation of another embodiment of the invention.

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Figure 9a – 9c show the closure and ferrule arrangement of the dispenser of Figure 8.

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### Detailed Description of the Drawings

The upper portion of a known medicament dispenser is shown in cross section in Figure 1 of the accompanying drawings. This comprises a metal can body 10 and a metal closure 20 having a ferrule 22 the lower end of which is crimped around an upper wall portion 12 of the can body 10. The closure 20 has a downwardly opening annular channel 25 within which is received a sealing gasket 30. The upper edge of the ferrule 22 of the can body 10 is in sealing engagement with the gasket 30.

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The medicament dispenser is provided with a valve arrangement 40, the purpose of which is to enable metered doses of a material held under pressure within the can body 10 to be dispensed. The valve arrangement 40 includes a metering chamber 41, within which a dose of medicament is held prior to being dispensed, and a hollow stem 42 which is longitudinally movable with respect to the chamber 41. The stem 42 has a transfer port 44 and an outlet 45. When the stem is depressed from the position shown, the dose passes from the chamber 41 through the port 44 into the stem, and from there it passes out through the outlet 45. The stem 42 is in slidably sealing engagement with an aperture formed in the centre of a sealing ring 35.

Figure 2 shows a cross sectional view of a dispenser according to the invention. The principal components of the dispenser are identical to those shown in Figure 1 except that the gasket 30 (of Figure 1) is now redundant due to the presence of laser weld 150. As can be seen, the body 110 is attached to closure 120 by means of laser weld 150 between ferrule 122 and upper body wall portion 112. Laser source 160 directs beam 162 at the mating surfaces of ferrule 122 and wall portion 112 to form weld 150. The laser beam 162 is directed at an angle of approximately 30 degrees to the vertical of body portion 112 to equilibrate heating rates of the ferrule 122 and

portion 112 which can dissipate heat more effectively. Thus the beam 162 is angled more towards the body portion 112 than the ferrule 122. The welding operation may be carried out when the dispenser components are in an upright (as shown) or inverted position. A 390 degree overlapping weld is produced around the body 110 of the dispenser by relative movement of laser beam 162 with respect to the mating surfaces of the ferrule 122 and upper wall portion 112. A double weld (not shown) will be produced in the 30 degree region of overlap.

10 Laser welding enables only very localised heating to be produced in the region of the weld itself. This may enable the can to be filled before the closure is secured thereto (the alternative being to fill the can through the valve arrangement) since it reduces the risk of the medicament being undesirably heated.

15 The metal containers are typically composed of aluminium or stainless steel and the interior surfaces may be coated with materials, such as fluoropolymers, which reduce the tendency of medicament to adhere thereto. The ferrule and flanges may also be composed of aluminium or stainless steel.

20 The laser source can be any source suitable for laser welding. Typically the maximum average power is from 10W to 200W, preferably from 25W to 100W and the maximum peak power is from 1kW to 10kW, preferably from 25 1kW to 3kW.

The pulse width is typically from 0.5 to 20 microseconds, and the maximum pulse energy from 10 to 100 Joules, preferably from 25 to 50 Joules.

30 Advantages of the use of laser welding in the fabrication of the dispenser of the invention include precisely controllable low weld energy enabling the

weld to be formed in a precise manner without affecting any of the other parts of the dispenser or the chemical contents of the container. The laser welds are furthermore clean and produce welds which are hermetic in nature. Also, since laser output is typically very stable it is possible to 5 achieve consistent weld repeatability. Furthermore, laser welding offers the additional benefits of speed over contact based welding methods such as ultrasonic welding.

The dispenser of Figure 3 is essentially identical to that of Figure 2 but 10 differs in the orientation of the ferrule and a flange structure on the container body. Figure 3 illustrates laser welding of the ferrule 222 to annular, planar flange 212, forming part of the body 210, which are both outwardly directed in relation to the orientation of the body 210 and the closure 220. Laser weld 250 is produced by a laser beam 262, emanating from source 260. The 15 beam 262 is angled at approximately 30 degrees in relation to the mating surfaces of ferrule 222 and flange 212 to equilibrate heating rates of the two surfaces. A 30 degree overlapping double weld (not shown) is effected by revolving the beam 262 or the mating surface of the ferrule 222 and flange 214 through 390 degrees.

20 When the flange 212 and ferrule 222 have the form shown in Figure 3, the contents of the dispenser, being under pressure, exert a peel force on the weld between the flanges. A welded joint is relatively weak under a peel force, though nevertheless strong enough to withstand any force to which it 25 is reasonably likely to be exposed. If, however, it is desired to avoid exposing the welded join to a peel force, the flange and ferrule can alternatively have the shape in Figure 4 wherein they are axially directed and cylindrical. To achieve this, either the flange and ferrule may be welded in the form shown in Figure 3, and then bent through 90 degrees, or they may 30 be bent first and welded afterwards.

As shown in Figure 4, the ferrule 322 is slightly splayed to aid alignment and to promote an interference (or at least a transition) fit at the top periphery. This fit between the flange 312 and ferrule 322 at the top is necessary because the presence of any gap therebetween will undesirably permit the 5 laser beam 362 to irradiate the contents of the container body 310 rather than contacting and heating the mating surfaces of the flange 312 and ferrule 322. Alternatively, the laser beam 362 can be angled to prevent entry into the container body 310 and equilibrate heating rates of the mating surfaces.

10

To effect an overlapping, continuous weld, a laser beam 362 is directed at the peripheral joint of the body 310 and ferrule 322. The body 310 and ferrule 322 assembly can be spun in the presence of a stationary laser beam 362, or alternatively, the laser beam may be rotated around a stationary 15 assembly. Welding continues until a continuous overlapping peripheral weld 350 is produced. The extent of overlap may vary, an overlap of 30 degrees producing a partial double weld which provides a reproducible, hermetic seal.

20 An alternative to the flange shape of Figure 4 as a way of avoiding subjecting the weld joint to a shear force is shown in Figure 5, in which the flange 412 of the body 410 and the ferrule 422 are welded in the shape shown in Figure 3, and then bent downwardly.

25 Correctly carried out laser welding should give a completely leakproof seal between the flanges. However, it is possible as a precaution to further seal the flange and ferrule together by having inter-engaging U-shaped portions on the body and closure. This is shown in Figure 6 and Figures 7a to 7c which show successive steps in sealing the closure 520 to the body 510 to 30 form the construction shown in Figure 6. The laser weld is formed after the closure 620 and body 610 have been formed as shown in Figure 7a and

assembled with one another, but before the rolling and crimping operations of Figures 7a and 7c have been carried out.

Figure 8 depicts another embodiment of an aerosol dispenser of the present invention. The container body 710 is cylindrical in nature, is composed of aluminium and has a raised base 715 and narrowed neck 717. A valve arrangement 740 (shown in simplified fashion) is seated in the open end of the container body 710 and is used to dispense a measured dose of medicament from the interior of the container body 710 via hollow stem 742.

5 The valve arrangement is seated in position by means of closure 720. The closure comprises a ferrule 722 which can be welded with the upper wall portion 712 with laser energy. A laser beam 762, angled at approximately 30 degrees to the vertical of body 710, is generated from source 760 onto the mating surfaces of the ferrule 722 and wall portion 712. To prevent the 10 build up of purging gases (e.g. Argon) during the welding process, which may weaken the weld produced, a series of indents or dimples (not shown) are pre-formed in the mating surfaces of the ferrule 722 and/or wall portion 712. These dimples allow gaseous escape during the initial stages of the 15 welding process. An overlapping, continuous laser weld 750 is formed between the mating surfaces of the ferrule 722 and wall 712 which extends 20 more than 360 degrees around the circumference of the container neck 717. The weld 750 is produced by rotating the dispenser through, for example, 390 degrees whilst the laser source 760 remains stationary, or the laser source 760 is rotated around the stationary dispenser. In this way, a double 25 weld (not shown) is produced in the 30 degree region of overlap around the neck 717 of the container.

Figures 9a – 9c are schematic diagrams of the closure 820 of Figure 8 and 30 illustrate the dimples or indents 827 described above. A sectional view of the cylindrical closure 820 is seen in Figure 9a to comprise top 823 and ferrule 822. The ferrule has three dimples or indents 827 cut into its interior

surface which forms the mating surface with the body of the container (not shown). Only three dimples 827 are shown in the diagram, equispaced at approximately 120 degrees to each other, although more dimples can be used to effect gaseous release during the laser welding process. An 5 enlarged view of the highlighted area of the ferrule 827, graphically illustrating the nature of the dimple 827, is shown in Figure 9b. A plan view of the closure 820 is seen in Figure 9c.

Whilst Figures 1 to 9c describe particular embodiments in which a valved ferrule is weldable to a metal can body other variations are possible. In 10 particular, embodiments are envisaged in which a valved can body is weldable to a base ferrule. The base ferrule may be either dome shaped or essentially flat.

15 It may be appreciated that any of the parts of the dispenser or actuator which contact the medicament suspension may be coated with materials such as fluoropolymer materials (e.g. PTFE or FEP) which reduce the tendency of medicament to adhere thereto. Any movable parts may also have coatings applied thereto which enhance their desired movement 20 characteristics. Frictional coatings may therefore be applied to enhance frictional contact and lubricants (e.g. silicone oil) used to reduce frictional contact as necessary.

The medicament dispenser of the invention is suitable for dispensing 25 medicament, particularly for the treatment of respiratory disorders such as asthma and chronic obstructive pulmonary disease (COPD).

Appropriate medicaments may thus be selected from, for example, analgesics, e.g., codeine, dihydromorphine, ergotamine, fentanyl or 30 morphine; anginal preparations, e.g., diltiazem; antiallergics, e.g., cromoglycate (eg s the sodium salt), ketotifen or nedocromil (e.g. as the

sodium salt); antiinfectives e.g., cephalosporins, penicillins, streptomycin, sulphonamides, tetracyclines and pentamidine; antihistamines, e.g., methapyrilene; anti- inflammatories, e.g., beclomethasone (e.g. as the dipropionate ester), fluticasone (e.g. as the propionate ester), flunisolide, 5 budesonide, rofleponide, mometasone e.g. as the furoate ester), ciclesonide, triamcinolone (e.g. as the acetonide) or 6 $\alpha$ , 9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-16 $\alpha$ -methyl-3-oxo-17 $\alpha$ -propionyloxy-androsta-1,4-diene-17 $\beta$ -carbothioic acid S-(2-oxo-tetrahydro-furan-3-yl) ester; antitussives, e.g., noscapine; bronchodilators, e.g., albuterol (e.g. as free base or sulphate), salmeterol 10 (e.g. as xinafoate), ephedrine, adrenaline, fenoterol (e.g. as hydrobromide), formoterol (e.g. as fumarate), isoprenaline, metaproterenol, phenylephrine, phenylpropanolamine, pirbuterol (e.g. as acetate), reproterol (e.g. as hydrochloride), rimiterol, terbutaline (e.g. as sulphate), isoetharine, tulobuterol or 4-hydroxy-7-[2-[[2-[[3-(2- 15 phenylethoxy)propyl]sulfonyl]ethyl]amino]ethyl-2(3H)-benzothiazolone; adenosine 2a agonists, e.g. 2R,3R,4S,5R)-2-[6-Amino-2-(1S-hydroxymethyl-2-phenyl-ethylamino)-purin-9-yl]-5-(2-ethyl-2H-tetrazol-5-yl)-tetrahydro-furan-3,4-diol (e.g. as maleate);  $\alpha$ 4 integrin inhibitors e.g. (2S)-3-[4-((4-(aminocarbonyl)-1-piperidinyl]carbonyl)oxy)phenyl]-2-[((2S)-4-methyl-2-{{2- 20 (2-methylphenoxy) acetyl]amino}pentanoyl)amino] propanoic acid (e.g. as free acid or potassium salt), diuretics, e.g., amiloride; anticholinergics, e.g., ipratropium (e.g. as bromide), tiotropium, atropine or oxitropium; hormones, e.g., cortisone, hydrocortisone or prednisolone; xanthines, e.g., aminophylline, choline theophyllinate, lysine theophyllinate or theophylline; 25 therapeutic proteins and peptides, e.g., insulin or glucagon; vaccines, diagnostics, and gene therapies. It will be clear to a person skilled in the art that, where appropriate, the medicaments may be used in the form of salts, (e.g., as alkali metal or amine salts or as acid addition salts) or as esters (e.g., lower alkyl esters) or as solvates (e.g., hydrates) to optimise the 30 activity and/or stability of the medicament.

Preferred medicaments are selected from albuterol, salmeterol, fluticasone propionate and beclomethasone dipropionate and salts or solvates thereof, e.g., the sulphate of albuterol and the xinafoate of salmeterol.

5 Medicaments can also be delivered in combinations. Preferred formulations containing combinations of active ingredients contain salbutamol (e.g., as the free base or the sulphate salt) or salmeterol (e.g., as the xinafoate salt) or formoterol (e.g. as the fumarate salt) in combination with an antiinflammatory steroid such as a beclomethasone ester (e.g., the dipropionate) or a fluticasone ester (e.g., the propionate) or budesonide. A particularly preferred combination is a combination of fluticasone propionate and salmeterol, or a salt thereof (particularly the xinafoate salt). A further combination of particular interest is budesonide and formoterol (e.g. as the fumarate salt).

15 It will be understood that the present disclosure is for the purpose of illustration only and the invention extends to modifications, variations and improvements thereto.

20 The application of which this description and claims form part may be used as a basis for priority in respect of any subsequent application. The claims of such subsequent application may be directed to any feature or combination of features described therein. They may take the form of product, method or use claims and may include, by way of example and 25 without limitation, one or more of the following claims:

## CLAIMS

1. An aerosol dispenser comprising a body and a closure sealed to the body;
- 5 said closure comprising an annular metal ferrule extending circumferentially around the axis of the closure and provided with a valve arrangement for dispensing material from the interior of the dispenser,
- 10 characterised in that the closure welds directly to said body by an overlapping metal-to-metal laser weld extending around the body to produce a double weld in the region of overlap and provide a hermetic seal between the mating surfaces of the body and said ferrule.
- 15 2. An aerosol dispenser according to claim 1, wherein said overlapping weld is a continuous weld which extends from 365 to 720 degrees around the axis of the body and the closure.
3. An aerosol dispenser according to claim 2, wherein said weld extends
- 20 from 380 to 540 degrees around said axis.
4. An aerosol dispenser according to any of claims 1 to 3, wherein the mating surfaces of the ferrule or the body comprise one or more dimples or indents.
- 25 5. An aerosol dispenser according to any of claims 1 to 4, wherein the overlapping weld is between the ferrule and an annular flange forming part of the body, said flange being axially directed and cylindrical.

6. An aerosol dispenser according to any of claims 1 to 4, wherein the overlapping weld is between the ferrule and an annular flange forming part of the body, said ferrule and flange being outwardly directed and flat.

5 7. An aerosol dispenser according to any of claims 1 to 6, wherein the dispenser is charged with an aerosol suspension.

10 8. An aerosol dispenser according to claim 7, wherein said aerosol suspension comprises a medicament and a propellant.

15 9. An aerosol dispenser according to claim 8, wherein said medicament is selected from the group consisting of albuterol, salmeterol, fluticasone propionate and beclomethasone dipropionate and salts or solvates thereof and any mixtures thereof.

20 10. An aerosol dispenser according to either of claims 8 or 9, wherein the propellant is selected from the group consisting of 1,1,1,2-tetrafluoroethane and 1,1,1,2,3,3,3-heptafluoropropane.

25 11. A method of assembling an aerosol dispenser comprising a metal body and a closure, said closure comprising an annular ferrule extending circumferentially around the axis of the closure and provided with a valve arrangement for dispensing material from the interior of the dispenser, characterised by applying laser energy to the mating surfaces of said ferrule and the body to produce an overlapping metal-to-metal laser weld extending around the body to form a double weld in the region of overlap and provide a hermetic seal between the body and the ferrule.

30

12. A method according to claim 11, wherein the ferrule is positioned at the open end of and co-axially with the body such that the mating surfaces are in contact with each other.
- 5 13. A method according to either of claims 11 or 12, wherein the weld is a continuous weld extending from 365 to 720 degrees about the axis of the body and the closure.
- 10 14. A method according to claim 13, wherein said weld extends from 380 to 540 degrees about said axis.
- 15 15. A method according to any of claims 11 to 14, wherein the mating surfaces comprise one or more dimples or indents.
- 15 16. A method according to any of claims 11 to 15, wherein said laser energy is applicable at an angle of from 10 to 80 degrees to the axis of orientation of the mating surfaces of the ferrule and body.
- 20 17. A method according to claim 16, wherein said angle is from 20 to 40 degrees.
- 25 18. A method of assembling an aerosol dispenser according to any of claims 11 to 17, wherein the closure is positioned at the open end of and co-axially with the body, said body comprising a complementary annular flange extending circumferentially about its axis such that the ferrule and said flange are parallel and in contact with each other.
19. A method according to claim 18, wherein the ferrule and the flange are outwardly directed and flat.

20. A method according to claim 19 wherein the ferrule and the flange are bent to lie in a substantially axial direction after the ferrule and the flange have been welded together.

5 21. A method according to claim 18, wherein the ferrule and flange are axially directed and cylindrical.

22. A method according to any of claims 11 to 21, wherein the ferrule and the flange are first welded together then rolled and crimped together.

10 23. A method according to any of claims 11 to 21, wherein the ferrule and flange are first rolled and crimped together then laser welded to each other.

15 24. A method according to any of claims 11 to 23, wherein the laser welding is conducted by means of a laser source having a maximum average power of from 10W to 200W, and a maximum peak power of from 1kW to 10kW.

20 25. A method according to claim 24 wherein said laser source has a pulse width of from 0.5 to 20 microseconds and a maximum pulse energy of from 10 to 100 Joules.

25 26. A method according to either of claims 24 or 25, wherein the laser source utilises a square wave modulated beam.

27. A method according to any of claims 24 to 26, wherein the width of the weld produced is in the range of 0.4 to 0.8 millimetres.

30 28. A method according to claim 27, wherein the width of the weld produced is 0.6 millimetres.

1/6

FIG. 1

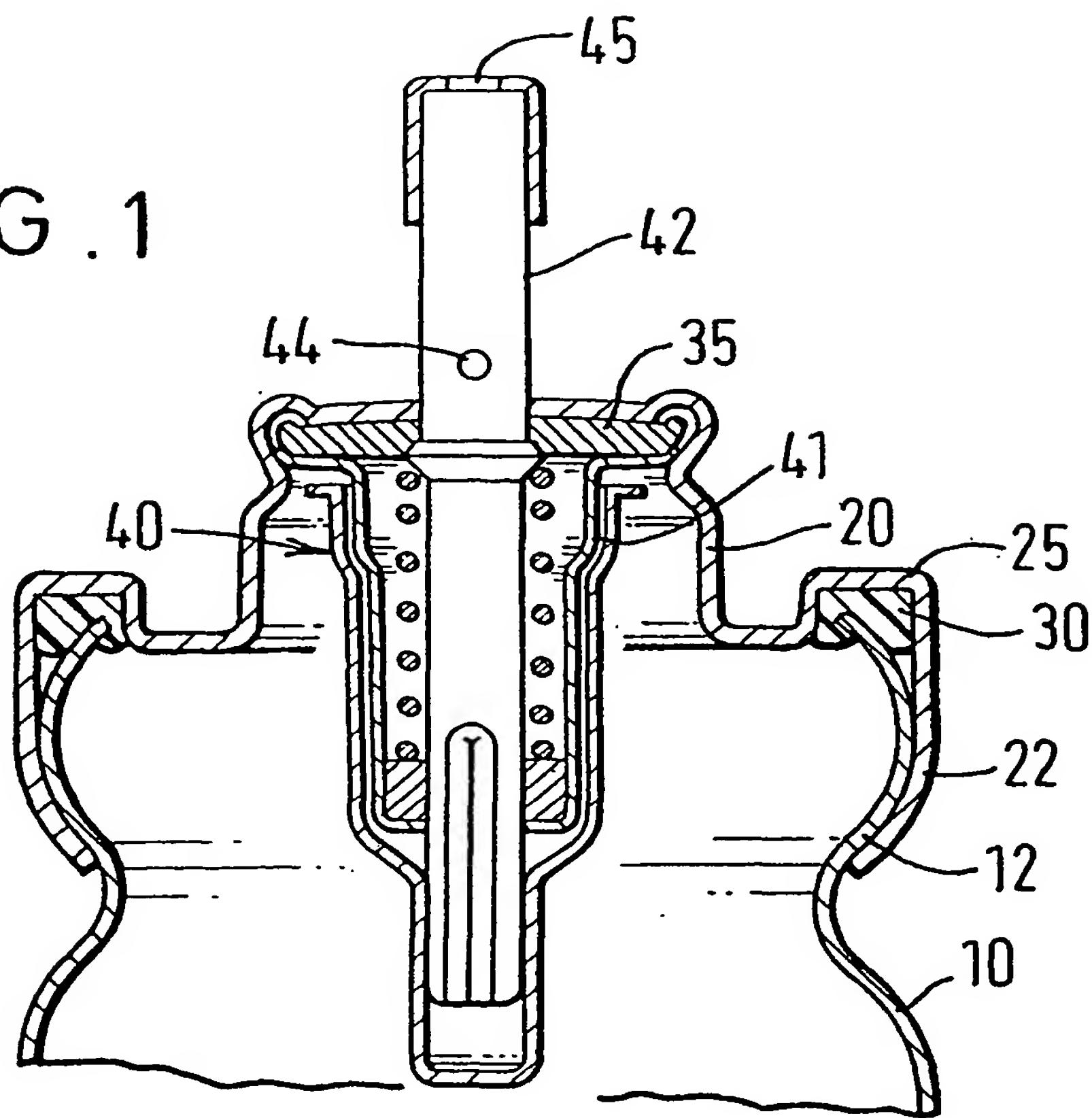
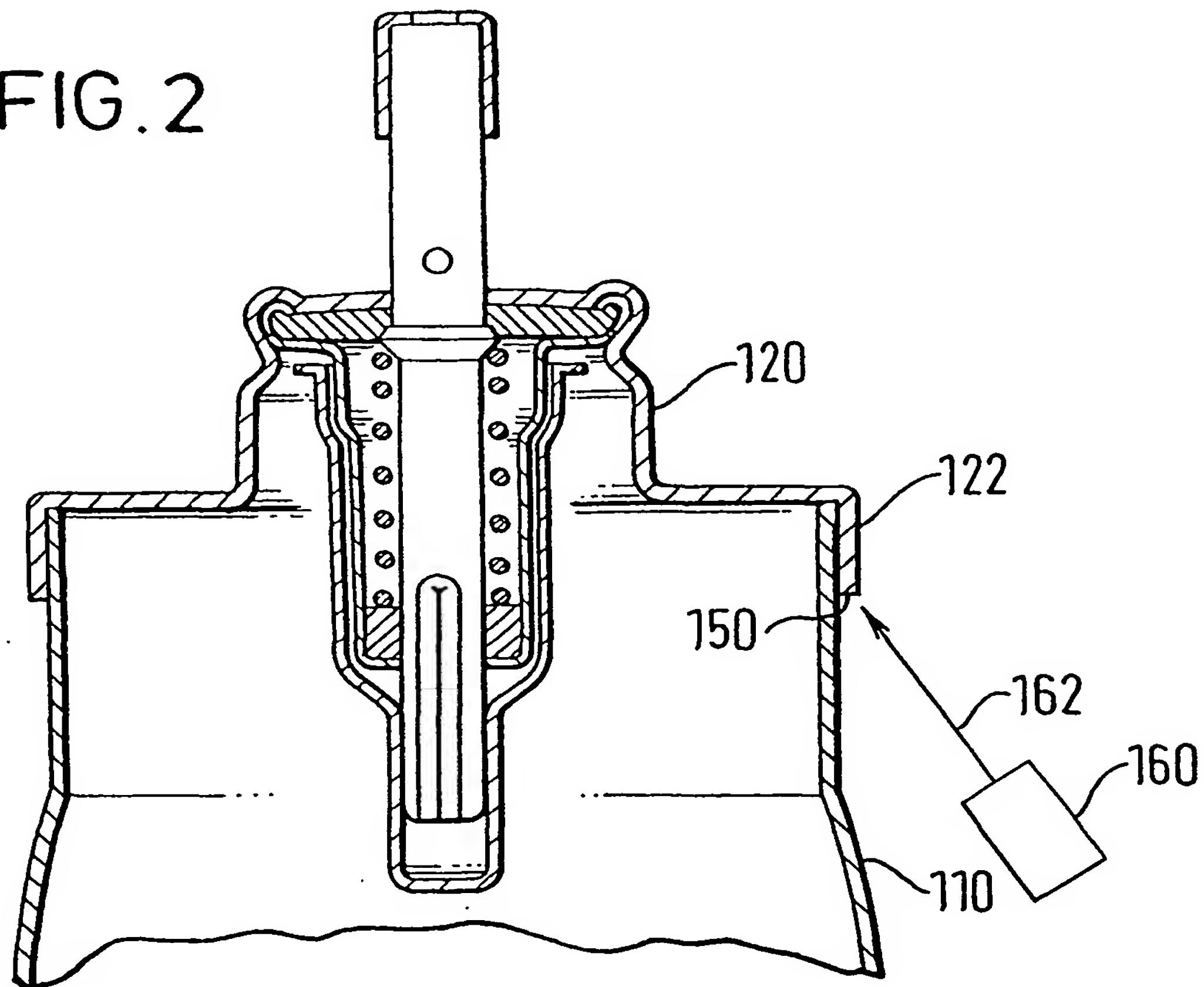


FIG. 2



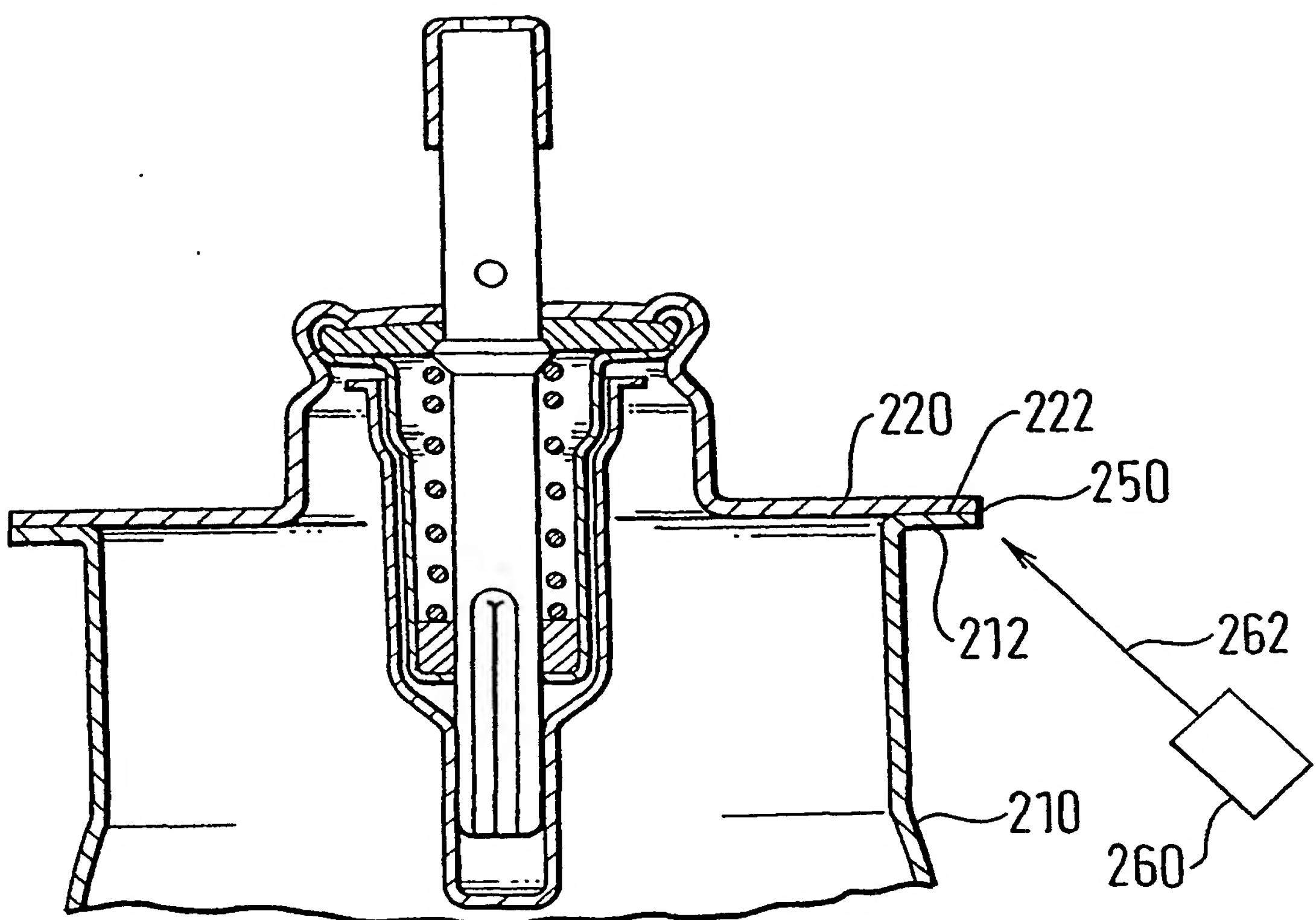


FIG. 3

FIG. 4

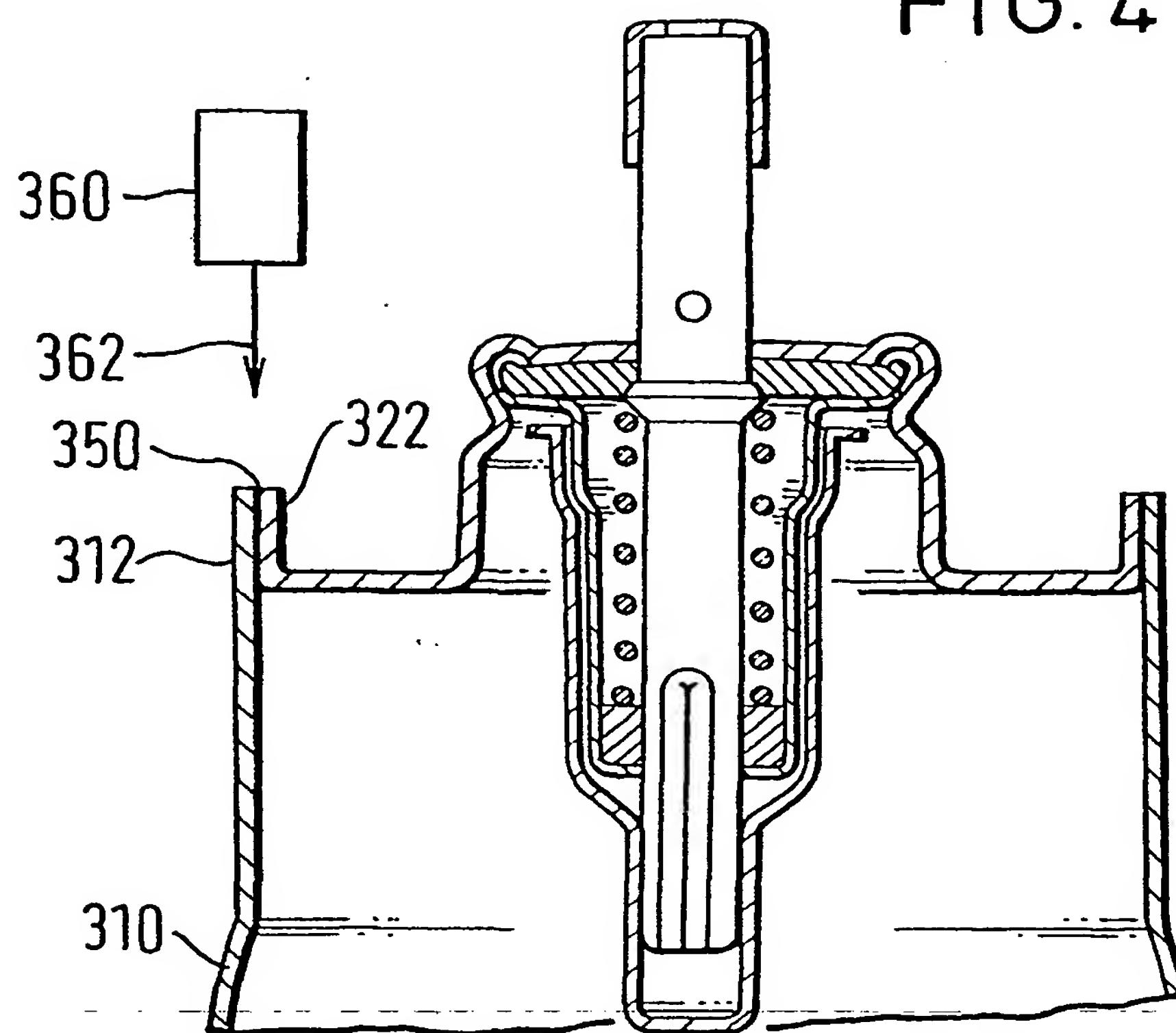


FIG. 5

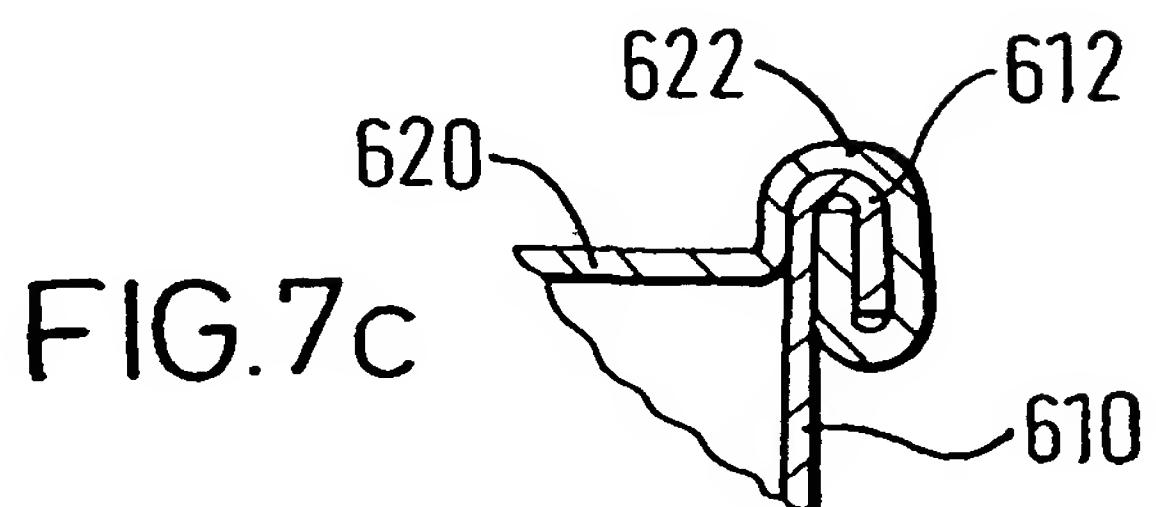
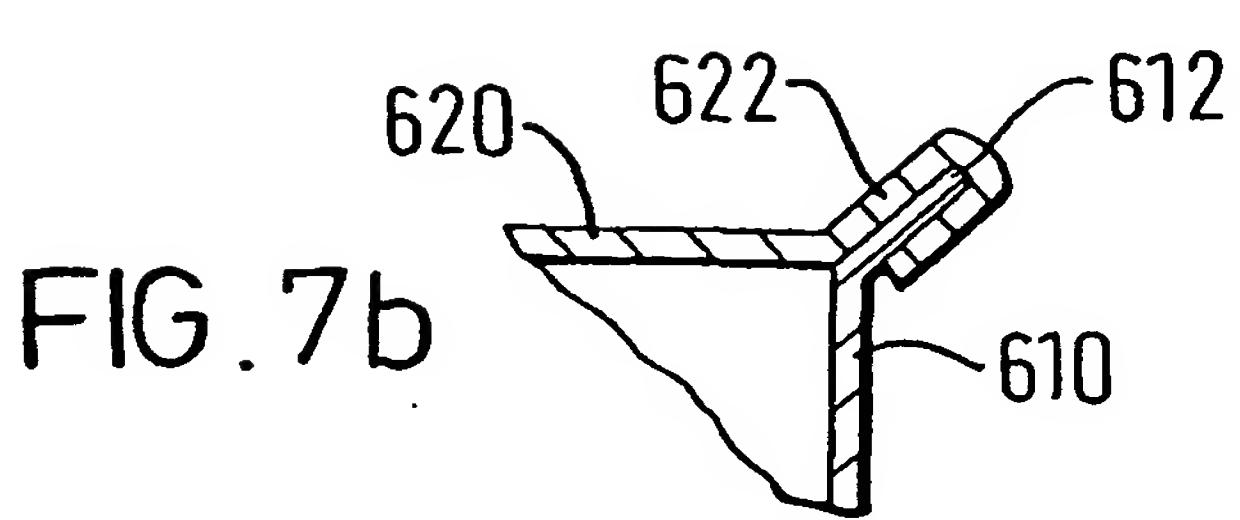
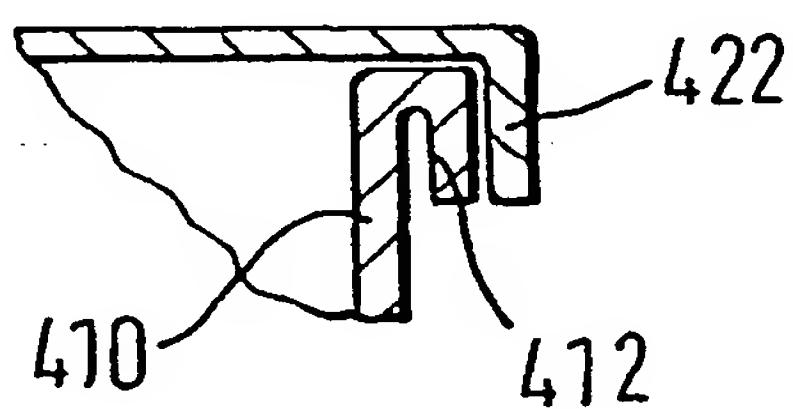


FIG.6 4/6

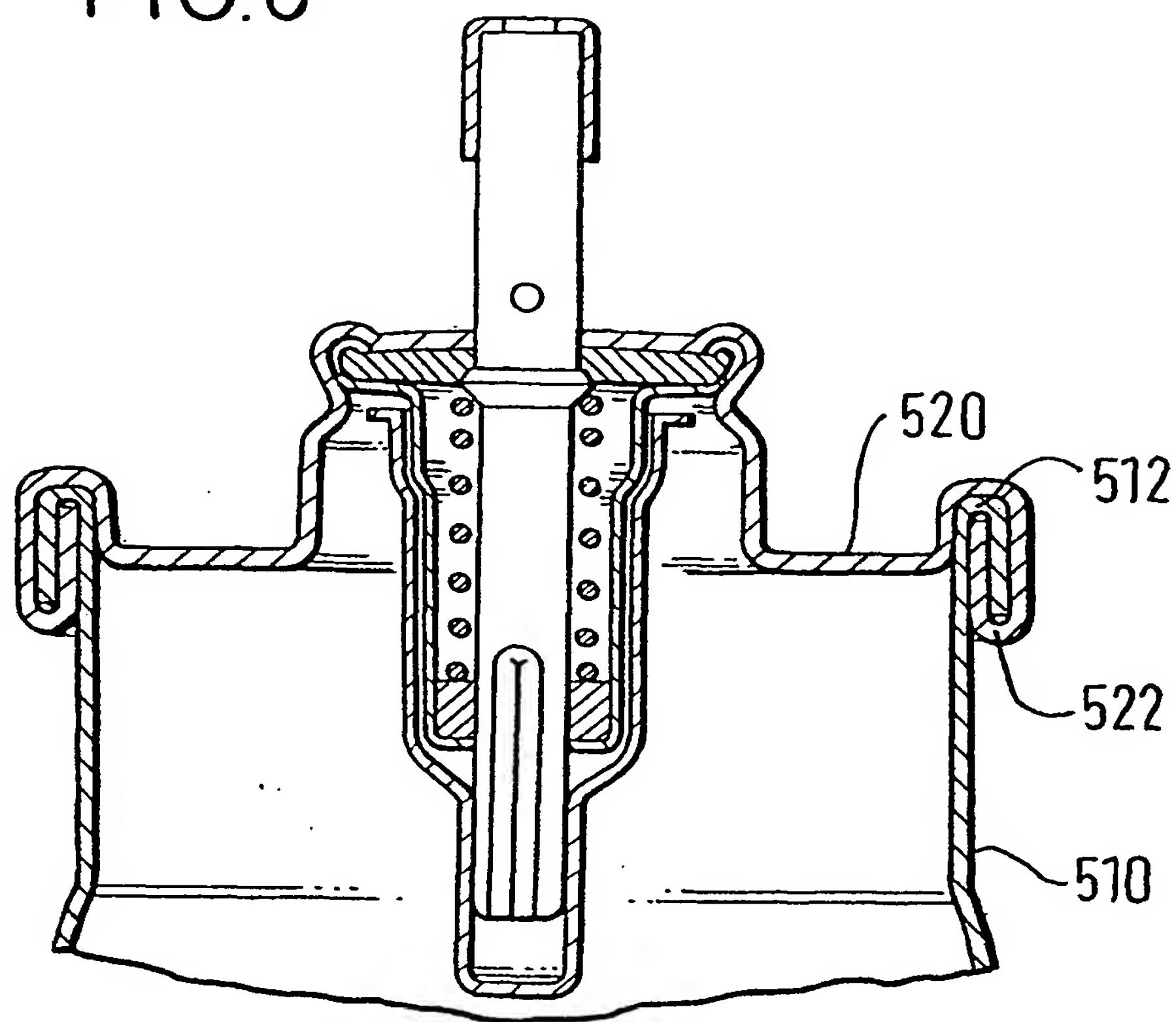
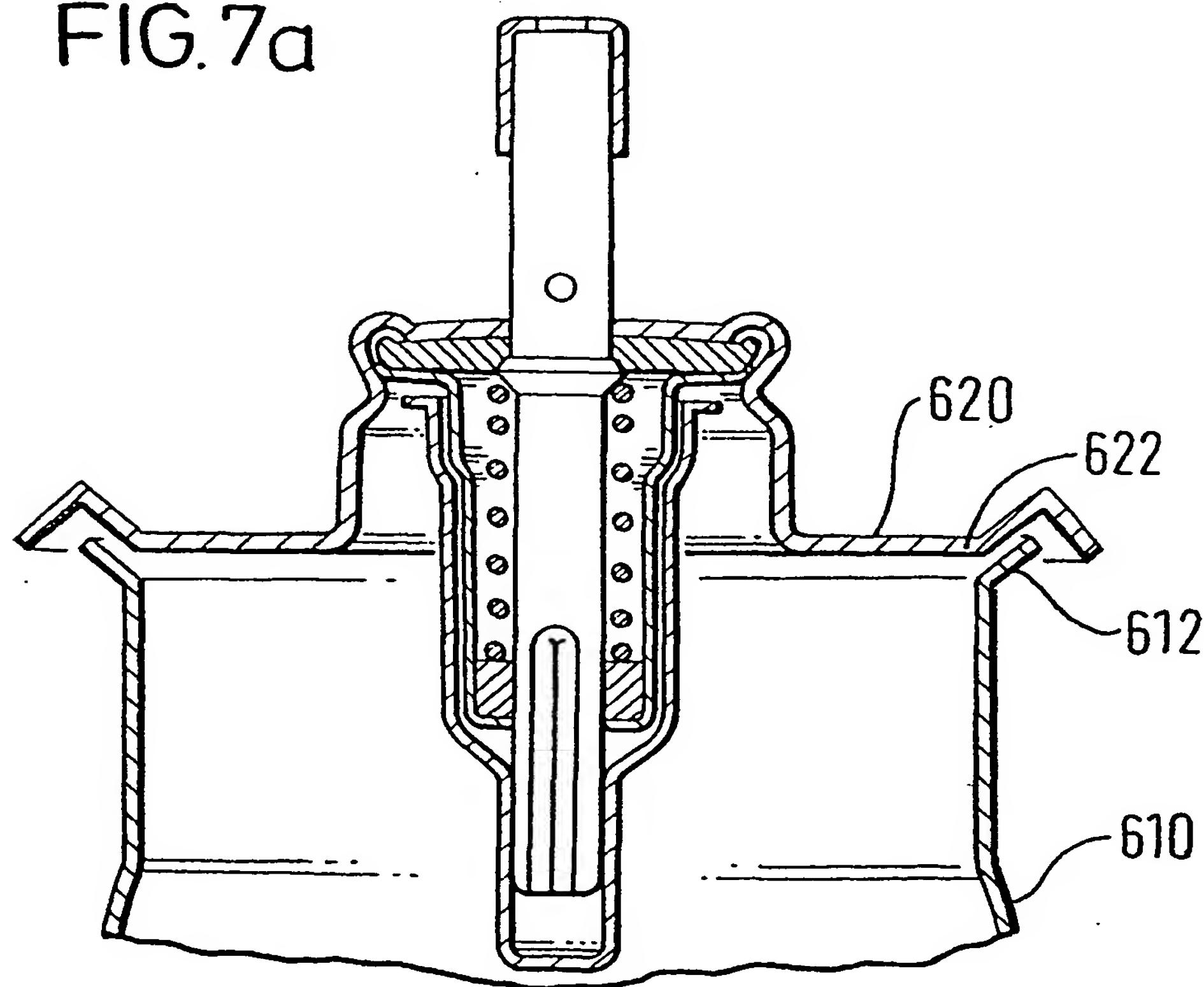


FIG.7a



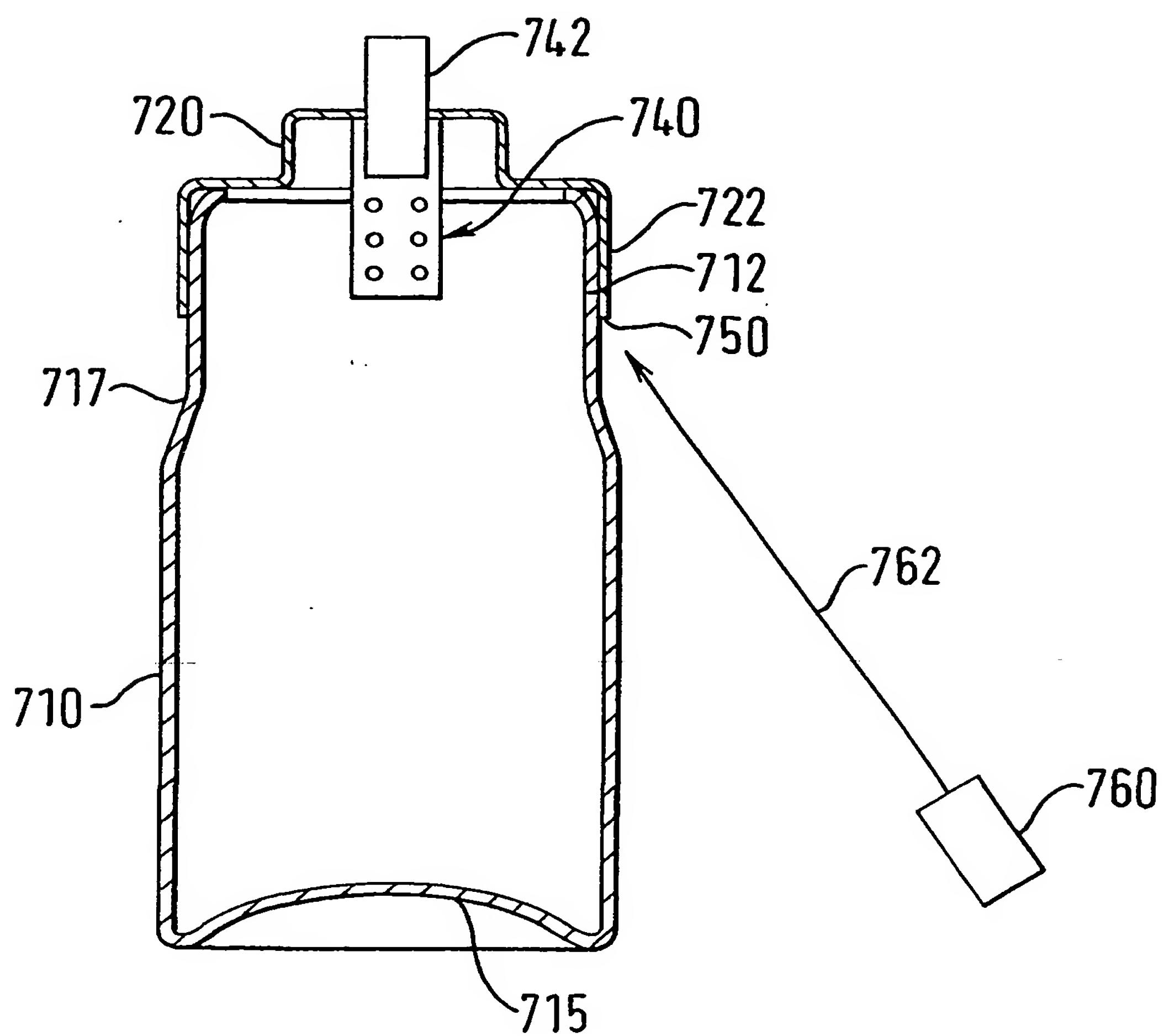


FIG. 8

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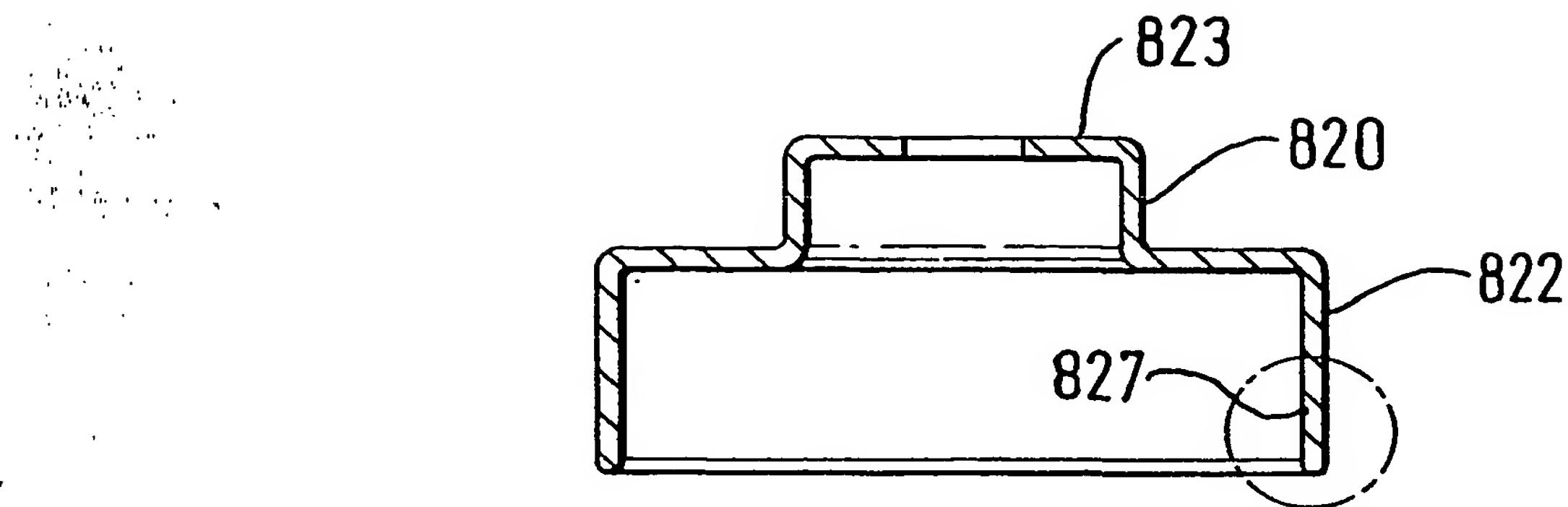


FIG. 9a

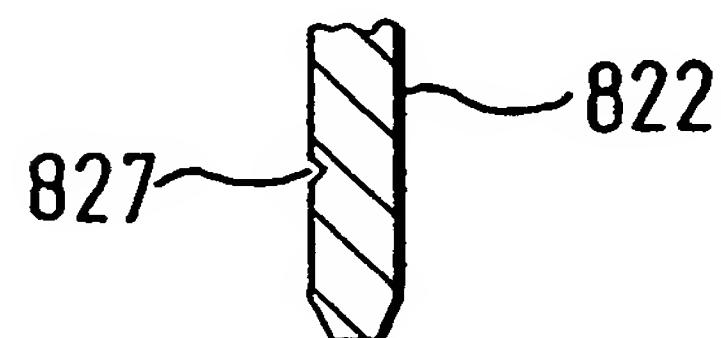


FIG. 9b

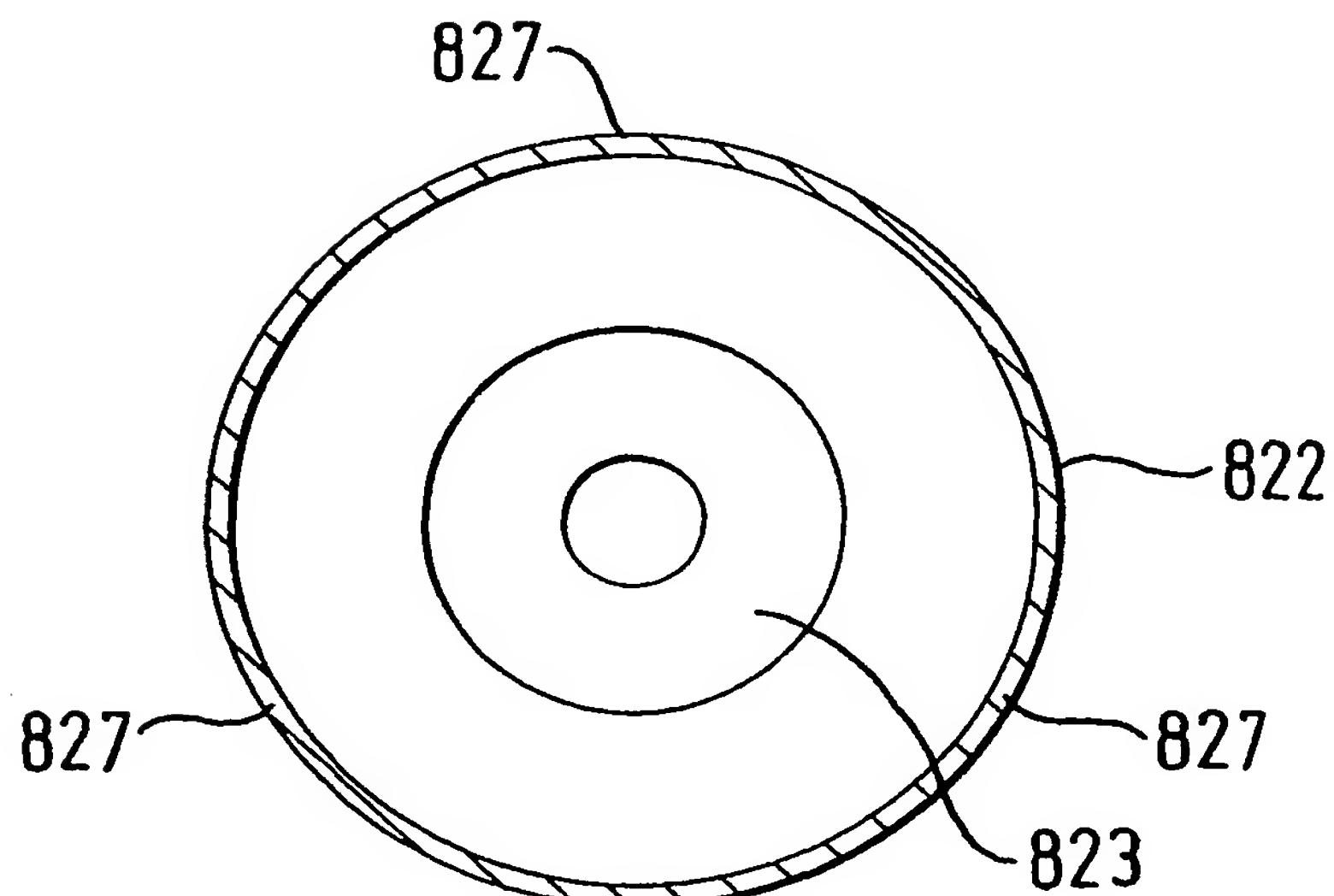


FIG. 9c

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 02/03327

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 B65D83/14 B23K26/24 B23K26/28

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
 IPC 7 B65D B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.             |
|----------|---|-----------------------------------|
| Y        | WO 00 35772 A (MAGUIRE TAYLOR ANTHONY JOHN<br>;GLAXO GROUP LTD (GB))<br>22 June 2000 (2000-06-22)<br><br>the whole document<br>---                      | 1-3,<br>5-14,<br>18-22,<br>24, 25 |
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| A        | ---   | 4, 15, 23                         |

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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Date of the actual completion of the international search

6 June 2002

Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.            |
|----------|---|----------------------------------|
| A        | EP 0 200 098 A (HUBER KARL)<br>5 November 1986 (1986-11-05)<br>page 19, paragraph 2<br>figures 1,3-6,14-18<br>---   | 1,11,16,<br>17                   |
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| A        | US 5 186 592 A (BUEDENBENDER BERND)<br>16 February 1993 (1993-02-16)<br><br>column 4, line 16 - line 27<br>figure 1<br>-----  | 1-3,<br>5-14,<br>18-22,<br>24,25 |

## INTERNATIONAL SEARCH REPORT

## Information on patent family members

International Application No

PCT/EP 02/03327

| Patent document cited in search report |   | Publication date |  | Patent family member(s)   |  | Publication date   |
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